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1 [External memory algorithms and data structures: dealing with massive data](#)



Jeffrey Scott Vitter

 June 2001 **ACM Computing Surveys (CSUR)**, Volume 33 Issue 2

Publisher: ACM Press

 Full text available: [pdf\(828.46 KB\)](#)

 Additional Information: [full citation](#), [abstract](#), [references](#), [citations](#), [index terms](#)

Data sets in large applications are often too massive to fit completely inside the computers internal memory. The resulting input/output communication (or I/O) between fast internal memory and slower external memory (such as disks) can be a major performance bottleneck. In this article we survey the state of the art in the design and analysis of external memory (or EM) algorithms and data structures, where the goal is to exploit locality in order to reduce the I/O costs. We consider a varie ...

Keywords: B-tree, I/O, batched, block, disk, dynamic, extendible hashing, external memory, hierarchical memory, multidimensional access methods, multilevel memory, online, out-of-core, secondary storage, sorting

2 [Special issue: Game-playing programs: theory and practice](#)



M. A. Bramer

 April 1982 **ACM SIGART Bulletin**, Issue 80

Publisher: ACM Press

 Full text available: [pdf\(9.23 MB\)](#)

 Additional Information: [full citation](#), [abstract](#)

This collection of articles has been brought together to provide SIGART members with an overview of Artificial Intelligence approaches to constructing game-playing programs. Papers on both theory and practice are included.

3 [I/O reference behavior of production database workloads and the TPC benchmarks— an analysis at the logical level](#)



Windsor W. Hsu, Alan Jay Smith, Honesty C. Young

 March 2001 **ACM Transactions on Database Systems (TODS)**, Volume 26 Issue 1

Publisher: ACM Press

 Full text available: [pdf\(5.42 MB\)](#)

 Additional Information: [full citation](#), [abstract](#), [references](#), [citations](#), [index terms](#)

As improvements in processor performance continue to far outpace improvements in

storage performance, I/O is increasingly the bottleneck in computer systems, especially in large database systems that manage huge amounts of data. The key to achieving good I/O performance is to thoroughly understand its characteristics. In this article we present a comprehensive analysis of the logical I/O reference behavior of the peak production database workloads from ten of the world's largest corporations ...

Keywords: I/O, TPC benchmarks, caching, locality, prefetching, production database workloads, reference behavior, sequentiality, workload characterization

4 PDS/PIO: lightweight libraries for collective parallel I/O

Judy Sturtevant, Mark Christon, Philip D. Heermann, Pang-Chieh Chen

November 1998 **Proceedings of the 1998 ACM/IEEE conference on Supercomputing (CDROM)**

Publisher: IEEE Computer Society

Full text available:  [html\(35.69 KB\)](#) Additional Information: [full citation](#), [abstract](#), [references](#), [citations](#)

PDS/PIO is a lightweight, parallel interface designed to support efficient transfers of massive, grid-based, simulation data among memory, disk, and tape subsystems. The higher-level PDS (Parallel Data Set) interface manages data with tensor and unstructured grid abstractions, while the lower-level PIO (Parallel Input/Output) interface accesses data arrays with arbitrary permutation, and provides communication and collective I/O operations. Higher-level data abstraction for finite element applications ...

Keywords: I/O, collective I/O, parallel I/O, scalable I/O

5 A project on high performance I/O subsystems

R. H. Katz

September 1989 **ACM SIGARCH Computer Architecture News**, Volume 17 Issue 5

Publisher: ACM Press

Full text available:  [pdf\(631.20 KB\)](#) Additional Information: [full citation](#), [citations](#), [index terms](#)

6 Improving the performance of log-structured file systems with adaptive methods

Jeanna Neefe Matthews, Drew Roselli, Adam M. Costello, Randolph Y. Wang, Thomas E. Anderson

October 1997 **ACM SIGOPS Operating Systems Review , Proceedings of the sixteenth ACM symposium on Operating systems principles SOSP '97**, Volume 31 Issue 5

Publisher: ACM Press

Full text available:  [pdf\(2.18 MB\)](#) Additional Information: [full citation](#), [references](#), [citations](#), [index terms](#)

7 Informed prefetching and caching

R. H. Patterson, G. A. Gibson, E. Ginting, D. Stodolsky, J. Zelenka

December 1995 **ACM SIGOPS Operating Systems Review , Proceedings of the fifteenth ACM symposium on Operating systems principles SOSP '95**, Volume 29 Issue 5




Publisher: ACM Press

Full text available:  [pdf\(2.13 MB\)](#) Additional Information: [full citation](#), [references](#), [citations](#), [index terms](#)




8 Automatic content-based retrieval of broadcast news

-  M. G. Brown, J. T. Foote, G. J. F. Jones, K. Sparck Jones, S. J. Young
January 1995 **Proceedings of the third ACM international conference on Multimedia**
Publisher: ACM Press
Full text available:  [htm\(51.60 KB\)](#) Additional Information: [full citation](#), [references](#), [citations](#), [index terms](#)

Keywords: ATM, atm, browsing, content-based retrieval, information retrieval, multimedia, television news, text subtitles




- 9 [Asynchronous scheduling of redundant disk arrays](#) 
 Peter Sanders
July 2000 **Proceedings of the twelfth annual ACM symposium on Parallel algorithms and architectures**
Publisher: ACM Press
Full text available:  [pdf\(161.35 KB\)](#) Additional Information: [full citation](#), [abstract](#), [references](#), [citations](#), [index terms](#)


Random redundant allocation of data to parallel disk arrays can be exploited to achieve low access delays. New algorithms are proposed which improve the previously known shortest queue algorithm by systematically exploiting that scheduling decisions can be deferred until a block access is actually started on a disk. These algorithms are also generalized for coding schemes with low redundancy. Using extensive experiments, practically important quantities are measured which have so far eluded ...

- 10 [RAID: high-performance, reliable secondary storage](#) 
 Peter M. Chen, Edward K. Lee, Garth A. Gibson, Randy H. Katz, David A. Patterson
June 1994 **ACM Computing Surveys (CSUR)**, Volume 26 Issue 2
Publisher: ACM Press
Full text available:  [pdf\(3.60 MB\)](#) Additional Information: [full citation](#), [abstract](#), [references](#), [citations](#), [index terms](#), [review](#)

Disk arrays were proposed in the 1980s as a way to use parallelism between multiple disks to improve aggregate I/O performance. Today they appear in the product lines of most major computer manufacturers. This article gives a comprehensive overview of disk arrays and provides a framework in which to organize current and future work. First, the article introduces disk technology and reviews the driving forces that have popularized disk arrays: performance and reliability. It discusses the tw ...

Keywords: RAID, disk array, parallel I/O, redundancy, storage, striping

- 11 [The HP AutoRAID hierarchical storage system](#) 
 J. Wilkes, R. Golding, C. Staelin, T. Sullivan
December 1995 **ACM SIGOPS Operating Systems Review , Proceedings of the fifteenth ACM symposium on Operating systems principles SOSP '95**, Volume 29 Issue 5
Publisher: ACM Press
Full text available:  [pdf\(1.60 MB\)](#) Additional Information: [full citation](#), [references](#), [citations](#), [index terms](#)

- 12 [The Panasas ActiveScale Storage Cluster - Delivering Scalable High Bandwidth Storage](#) 
Hong Tang, Aziz Gulbeden, Jingyu Zhou, William Strathearn, Tao Yang, Lingkun Chu
November 2004 **Proceedings of the 2004 ACM/IEEE conference on Supercomputing**

Publisher: IEEE Computer Society

Full text available:  [pdf\(199.24 KB\)](#) Additional Information: [full citation](#), [abstract](#)

Fundamental advances in high-level storage architectures and low-level storage-device interfaces greatly improve the performance and scalability of storage systems. Specifically, the decoupling of storage control (i.e., file system policy) from datapath operations (i.e., read, write) allows client applications to leverage the readily available bandwidth of storage devices while continuing to rely on the rich semantics of today's file systems. Further, the evolution of storage interfaces from blo ...

13 The HP AutoRAID hierarchical storage system



John Wilkes, Richard Golding, Carl Staelin, Tim Sullivan

February 1996 **ACM Transactions on Computer Systems (TOCS)**, Volume 14 Issue 1

Publisher: ACM Press

Full text available:  [pdf\(1.82 MB\)](#) Additional Information: [full citation](#), [abstract](#), [references](#), [citations](#), [index terms](#)

Configuring redundant disk arrays is a black art. To configure an array properly, a system administrator must understand the details of both the array and the workload it will support. Incorrect understanding of either, or changes in the workload over time, can lead to poor performance. We present a solution to this problem: a two-level storage hierarchy implemented inside a single disk-array controller. In the upper level of this hierarchy, two copies of active data are stored to provide f ...

Keywords: RAID, disk array, storage hierarchy


14 Performance evaluation of extended storage architectures for transaction processing



Erhard Rahm

June 1992 **ACM SIGMOD Record , Proceedings of the 1992 ACM SIGMOD international conference on Management of data SIGMOD '92**, Volume 21 Issue 2

Publisher: ACM Press

Full text available:  [pdf\(1.47 MB\)](#) Additional Information: [full citation](#), [abstract](#), [references](#), [citations](#), [index terms](#)

The use of non-volatile semiconductor memory within an extended storage hierarchy promises significant performance improvements for transaction processing. Although page-addressable semiconductor memories like extended memory, solid-state disks and disk caches are commercially available since several years, no detailed investigation of their use for transaction processing has been performed so far. We present a comprehensive simulation study that compares the performance of these storage ty ...

15 Operating systems: DualFS: a new journaling file system without meta-data duplication



Juan Piernas, Toni Cortes, José M. García

June 2002 **Proceedings of the 16th international conference on Supercomputing**


Publisher: ACM Press

Full text available:  [pdf\(213.64 KB\)](#) Additional Information: [full citation](#), [abstract](#), [references](#), [index terms](#)


In this paper we introduce DualFS, a new high performance journaling file system that puts data and meta-data on different devices (usually, two partitions on the same disk or on different disks), and manages them in very different ways. Unlike other journaling file systems, DualFS has only one copy of every meta-data block. This copy is in the *meta-data device*, a log which is used by DualFS both to read and to write meta-data blocks. By avoiding a time-expensive extra copy of meta-data b ...

Keywords: DualFS, journaling file system, meta-data management

16 A cost-effective, high-bandwidth storage architecture

 Garth A. Gibson, David F. Nagle, Khalil Amiri, Jeff Butler, Fay W. Chang, Howard Gobioff, Charles Hardin, Erik Riedel, David Rochberg, Jim Zelenka
October 1998 **ACM SIGOPS Operating Systems Review** , **ACM SIGPLAN Notices** ,
Proceedings of the eighth international conference on Architectural support for programming languages and operating systems ASPLOS-VIII, Volume 32 , 33 Issue 5 , 11


Publisher: ACM Press

Full text available:  [pdf\(1.67 MB\)](#)

Additional Information: [full citation](#), [abstract](#), [references](#), [citations](#), [index terms](#)

This paper describes the Network-Attached Secure Disk (NASD) storage architecture, prototype implementations of NASD drives, array management for our architecture, and three filesystems built on our prototype. NASD provides scalable storage bandwidth without the cost of servers used primarily, for transferring data from peripheral networks (e.g. SCSI) to client networks (e.g. ethernet). Increasing dataset sizes, new attachment technologies, the convergence of peripheral and interprocessor switch ...

17 Designing computer systems with MEMS-based storage

 Steven W. Schlosser, John Linwood Griffin, David F. Nagle, Gregory R. Ganger
November 2000 **ACM SIGOPS Operating Systems Review** , **ACM SIGARCH Computer Architecture News** , **Proceedings of the ninth international conference on Architectural support for programming languages and operating systems ASPLOS-IX**, Volume 34 , 28 Issue 5 , 5

Publisher: ACM Press

Full text available:  [pdf\(439.06 KB\)](#)

Additional Information: [full citation](#), [abstract](#), [references](#), [citations](#), [index terms](#)

For decades the RAM-to-disk memory hierarchy gap has plagued computer architects. An exciting new storage technology based on microelectromechanical systems (MEMS) is poised to fill a large portion of this performance gap, significantly reduce system power consumption, and enable many new applications. This paper explores the system-level implications of integrating MEMS-based storage into the memory hierarchy. Results show that standalone MEMS-based storage reduces I/O stall times by 4-74X over ...

18 Designing computer systems with MEMS-based storage

 Steven W. Schlosser, John Linwood Griffin, David F. Nagle, Gregory R. Ganger
November 2000 **ACM SIGPLAN Notices**, Volume 35 Issue 11

Publisher: ACM Press

Full text available:  [pdf\(439.06 KB\)](#)

Additional Information: [full citation](#), [abstract](#), [references](#), [index terms](#)

For decades the RAM-to-disk memory hierarchy gap has plagued computer architects. An exciting new storage technology based on microelectromechanical systems (MEMS) is poised to fill a large portion of this performance gap, significantly reduce system power consumption, and enable many new applications. This paper explores the system-level implications of integrating MEMS-based storage into the memory hierarchy. Results show that standalone MEMS-based storage reduces I/O stall times by 4-74X over ...

19 LH^{*}RS---a highly-available scalable distributed data structure

 Witold Litwin, Rim Moussa, Thomas Schwarz
September 2005 **ACM Transactions on Database Systems (TODS)**, Volume 30 Issue 3

Publisher: ACM Press

Full text available:  [pdf\(774.32 KB\)](#)

Additional Information: [full citation](#), [abstract](#), [references](#), [index terms](#)

LH^{*}RS is a high-availability scalable distributed data structure (SDDS). An LH^{*}RS

file is hash partitioned over the distributed RAM of a multicomputer, for example, a network of PCs, and supports the unavailability of any $k \geq 1$ of its server nodes. The value of k transparently grows with the file to offset the reliability decline. Only the number of the storage nodes potentially limits the file growth. The high-availability management uses a novel ...

Keywords: P2P, Scalable distributed data structure, grid computing, high-availability, linear hashing, physical database design

20 RAID-II: a high-bandwidth network file server



A. L. Drapeau, K. W. Shirriff, J. H. Hartman, E. L. Miller, S. Seshan, R. H. Katz, K. Lutz, D. A. Patterson, E. K. Lee, P. M. Chen, G. A. Gibson

April 1994 **ACM SIGARCH Computer Architecture News , Proceedings of the 21ST annual international symposium on Computer architecture ISCA '94**, Volume 22 Issue 2

Publisher: IEEE Computer Society Press, ACM Press

Full text available: [pdf\(1.43 MB\)](#)

Additional Information: [full citation](#), [abstract](#), [references](#), [citations](#), [index terms](#)

In 1989, the RAID (Redundant Arrays of Inexpensive Disks) group at U. C. Berkeley built a prototype disk array called RAID-I. The bandwidth delivered to clients by RAID-I was severely limited by the memory system bandwidth of the disk array's host workstation. We designed our second prototype, RAID-II, to deliver more of the disk array bandwidth to file server clients. A custom-built crossbar memory system called the XBUS board connects the disks directly to the high-speed network, allowing data ...

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1 [A Self-Organizing Storage Cluster for Parallel Data-Intensive Applications](#)

Hong Tang, Aziz Gulbeden, Jingyu Zhou, William Strathearn, Tao Yang, Lingkun Chu
November 2004 **Proceedings of the 2004 ACM/IEEE conference on Supercomputing**

Publisher: IEEE Computer Society

Full text available: [pdf\(330.26 KB\)](#) Additional Information: [full citation](#), [abstract](#)

Cluster-based storage systems are popular for data-intensive applications and it is desirable yet challenging to provide incremental expansion and high availability while achieving scalability and strong consistency. This paper presents the design and implementation of a self-organizing storage cluster called Sorrento, which targets data-intensive workload with highly parallel requests and low write-sharing patterns. Sorrento automatically adapts to storage node joins and departures, and the sys ...

2 [Link and channel measurement: A simple mechanism for capturing and replaying wireless channels](#)

Glenn Judd, Peter Steenkiste

August 2005 **Proceeding of the 2005 ACM SIGCOMM workshop on Experimental approaches to wireless network design and analysis E-WIND '05**

Publisher: ACM Press

Full text available: [pdf\(6.06 MB\)](#) Additional Information: [full citation](#), [abstract](#), [references](#), [index terms](#)

Physical layer wireless network emulation has the potential to be a powerful experimental tool. An important challenge in physical emulation, and traditional simulation, is to accurately model the wireless channel. In this paper we examine the possibility of using on-card signal strength measurements to capture wireless channel traces. A key advantage of this approach is the simplicity and ubiquity with which these measurements can be obtained since virtually all wireless devices provide the req ...

Keywords: channel capture, emulation, wireless

3 [Separating Abstractions from Resources in a Tactical Storage System](#)

Douglas Thain, Sander Klous, Justin Wozniak, Paul Brenner, Aaron Striegel, Jesus Izaguirre
November 2005 **Proceedings of the 2005 ACM/IEEE conference on Supercomputing SC '05**

Publisher: IEEE Computer Society

Full text available: [pdf\(401.40 KB\)](#)



Publisher Site

Additional Information: [full citation](#), [abstract](#)

Sharing data and storage space in a distributed system remains a difficult task for ordinary users, who are constrained to the fixed abstractions and resources provided by administrators. To remedy this situation, we introduce the concept of a tactical storage system (TSS) that separates storage abstractions from storage resources, leaving users free to create, reconfigure, and destroy abstractions as their needs change. In this paper, we describe how a TSS can provide a variety of filesystem an ...

4 [Interposed request routing for scalable network storage](#)

February 2002 **ACM Transactions on Computer Systems (TOCS)**, Volume 20 Issue 1

Publisher: ACM Press

Full text available: pdf(363.12 KB) Additional Information: [full citation](#), [abstract](#), [references](#), [citations](#), [index terms](#), [review](#)

This paper explores interposed request routing in Slice, a new storage system architecture for high-speed networks incorporating network-attached block storage. Slice interposes a request switching filter---called a μ proxy---along each client's network path to the storage service (e.g., in a network adapter or switch). The μ proxy intercepts request traffic and distributes it across a server ensemble. We propose request routing schemes for I/O and file service traffic, and explore th ...

Keywords: Content switch, file server, network file system, network storage, request redirection, service virtualization

5 [Client-server computing in mobile environments](#)



Jin Jing, Abdelsalam Sumi Helal, Ahmed Elmagarmid

June 1999 **ACM Computing Surveys (CSUR)**, Volume 31 Issue 2

Publisher: ACM Press

Full text available: pdf(233.31 KB) Additional Information: [full citation](#), [abstract](#), [references](#), [citations](#), [index terms](#), [review](#)

Recent advances in wireless data networking and portable information appliances have engendered a new paradigm of computing, called mobile computing, in which users carrying portable devices have access to data and information services regardless of their physical location or movement behavior. In the meantime, research addressing information access in mobile environments has proliferated. In this survey, we provide a concrete framework and categorization of the various way ...

Keywords: application adaptation, cache invalidation, caching, client/server, data dissemination, disconnected operation, mobile applications, mobile client/server, mobile computing, mobile data, mobility awareness, survey, system application

6 [System support for pervasive applications](#)



Robert Grimm, Janet Davis, Eric Lemar, Adam Macbeth, Steven Swanson, Thomas Anderson, Brian Bershad, Gaetano Borriello, Steven Gribble, David Wetherall

November 2004 **ACM Transactions on Computer Systems (TOCS)**, Volume 22 Issue 4

Publisher: ACM Press

Full text available: pdf(1.82 MB) Additional Information: [full citation](#), [abstract](#), [references](#), [index terms](#)

Pervasive computing provides an attractive vision for the future of computing. Computational power will be available everywhere. Mobile and stationary devices will dynamically connect and coordinate to seamlessly help people in accomplishing their tasks. For this vision to become a reality, developers must build applications that constantly adapt to a highly dynamic computing environment. To make the developers'

task feasible, we present a system architecture for pervasive computing, called & ...

Keywords: Asynchronous events, checkpointing, discovery, logic/operation pattern, migration, one.world, pervasive computing, structured I/O, tuples, ubiquitous computing

7 Astrolabe: A robust and scalable technology for distributed system monitoring, management, and data mining



Robbert Van Renesse, Kenneth P. Birman, Werner Vogels

May 2003 **ACM Transactions on Computer Systems (TOCS)**, Volume 21 Issue 2

Publisher: ACM Press

Full text available: pdf(341.62 KB) Additional Information: [full citation](#), [abstract](#), [references](#), [citations](#), [index terms](#)

Scalable management and self-organizational capabilities are emerging as central requirements for a generation of large-scale, highly dynamic, distributed applications. We have developed an entirely new distributed information management system called Astrolabe. Astrolabe collects large-scale system state, permitting rapid updates and providing on-the-fly attribute aggregation. This latter capability permits an application to locate a resource, and also offers a scalable way to track sys ...

Keywords: Aggregation, epidemic protocols, failure detection, gossip, membership, publish-subscribe, scalability

8 Design and evaluation of a conit-based continuous consistency model for replicated services



Haifeng Yu, Amin Vahdat

August 2002 **ACM Transactions on Computer Systems (TOCS)**, Volume 20 Issue 3

Publisher: ACM Press

Full text available: pdf(406.85 KB) Additional Information: [full citation](#), [abstract](#), [references](#), [citations](#), [index terms](#)

The tradeoffs between consistency, performance, and availability are well understood. Traditionally, however, designers of replicated systems have been forced to choose from either strong consistency guarantees or none at all. This paper explores the semantic space between traditional strong and optimistic consistency models for replicated services. We argue that an important class of applications can tolerate relaxed consistency, but benefit from bounding the maximum rate of inconsistent access ...

Keywords: Conit, consistency model, continuous consistency, network services, relaxed consistency, replication

9 4.2BSD and 4.3BSD as examples of the UNIX system



John S. Quarterman, Abraham Silberschatz, James L. Peterson

December 1985 **ACM Computing Surveys (CSUR)**, Volume 17 Issue 4

Publisher: ACM Press

Full text available: pdf(4.07 MB) Additional Information: [full citation](#), [abstract](#), [references](#), [citations](#), [index terms](#), [review](#)

This paper presents an in-depth examination of the 4.2 Berkeley Software Distribution, Virtual VAX-11 Version (4.2BSD), which is a version of the UNIX Time-Sharing System. There are notes throughout on 4.3BSD, the forthcoming system from the University of California at Berkeley. We trace the historical development of the UNIX system from its conception in 1969 until today, and describe the design principles that have guided this development. We then present the internal data structures and ...

10 Distributed systems - programming and management: On remote procedure call

Patricia Gomes Soares

November 1992 **Proceedings of the 1992 conference of the Centre for Advanced Studies on Collaborative research - Volume 2**

Publisher: IBM Press

Full text available:  pdf(4.52 MB) Additional Information: [full citation](#), [abstract](#), [references](#), [citations](#)

The Remote Procedure Call (RPC) paradigm is reviewed. The concept is described, along with the backbone structure of the mechanisms that support it. An overview of works in supporting these mechanisms is discussed. Extensions to the paradigm that have been proposed to enlarge its suitability, are studied. The main contributions of this paper are a standard view and classification of RPC mechanisms according to different perspectives, and a snapshot of the paradigm in use today and of goals for t ...

11 Paradigms for process interaction in distributed programs



Gregory R. Andrews

March 1991 **ACM Computing Surveys (CSUR)**, Volume 23 Issue 1

Publisher: ACM Press

Full text available:  pdf(3.77 MB) Additional Information: [full citation](#), [abstract](#), [references](#), [citations](#), [index terms](#), [review](#)

Distributed computations are concurrent programs in which processes communicate by message passing. Such programs typically execute on network architectures such as networks of workstations or distributed memory parallel machines (i.e., multicomputers such as hypercubes). Several paradigms—examples or models—for process interaction in distributed computations are described. These include networks of filters, clients, and servers, heartbeat algorithms, probe/echo algorithms, broa ...

Keywords: clients and servers, distributed and parallel algorithms, distributed programming, distributed programming methods, heartbeat algorithms, networks of filters, patterns for interprocess communication, probe/echo algorithms, replicated servers, token-passing algorithms

12 Serverless network file systems



Thomas E. Anderson, Michael D. Dahlin, Jeanna M. Neefe, David A. Patterson, Drew S. Roselli, Randolph Y. Wang

February 1996 **ACM Transactions on Computer Systems (TOCS)**, Volume 14 Issue 1

Publisher: ACM Press

Full text available:  pdf(2.69 MB) Additional Information: [full citation](#), [abstract](#), [references](#), [citations](#), [index terms](#)

We propose a new paradigm for network file system design: serverless network file systems. While traditional network file systems rely on a central server machine, a serverless system utilizes workstations cooperating as peers to provide all file system services. Any machine in the system can store, cache, or control any block of data. Our approach uses this location independence, in combination with fast local area networks, to provide better performance and scalability th ...

Keywords: RAID, log cleaning, log structured, log-based striping, logging, redundant data storage, scalable performance

13 Decentralized storage systems: Ivy: a read/write peer-to-peer file system

Athicha Muthitacharoen, Robert Morris, Thomer M. Gil, Benjie Chen

December 2002 **ACM SIGOPS Operating Systems Review**, Volume 36 Issue SI



Publisher: ACM Press

Full text available: [pdf\(1.65 MB\)](#)

Additional Information: [full citation](#), [abstract](#), [references](#)

Ivy is a multi-user read/write peer-to-peer file system. Ivy has no centralized or dedicated components, and it provides useful integrity properties without requiring users to fully trust either the underlying peer-to-peer storage system or the other users of the file system. An Ivy file system consists solely of a set of logs, one log per participant. Ivy stores its logs in the DHash distributed hash table. Each participant finds data by consulting all logs, but performs modifications by appendi ...

14 Lightweight causal and atomic group multicast



André Schiper, Kenneth Birman, Pat Stephenson

August 1991 **ACM Transactions on Computer Systems (TOCS)**, Volume 9 Issue 3

Publisher: ACM Press

Full text available: [pdf\(3.00 MB\)](#)

Additional Information: [full citation](#), [references](#), [citings](#), [index terms](#)

Keywords: fault-tolerant process groups, message ordering, multicast communication

15 An end-to-end approach to globally scalable network storage



Micah Beck, Terry Moore, James S. Plank

August 2002 **ACM SIGCOMM Computer Communication Review , Proceedings of the 2002 conference on Applications, technologies, architectures, and protocols for computer communications SIGCOMM '02**, Volume 32 Issue 4

Publisher: ACM Press

Full text available: [pdf\(286.82 KB\)](#)

Additional Information: [full citation](#), [abstract](#), [references](#), [citings](#), [index terms](#)

This paper discusses the application of end-to-end design principles, which are characteristic of the architecture of the Internet, to network storage. While putting storage into the network fabric may seem to contradict end-to-end arguments, we try to show not only that there is no contradiction, but also that adherence to such an approach is the key to achieving true scalability of shared network storage. After discussing end-to-end arguments with respect to several properties of network stora ...

Keywords: IBP, asynchronous communications, end-to-end design, exNode, internet backplane protocol, logistical networking, network storage, scalability, store and forward network, wide area storage

16 Language-level support for exploratory programming of distributed virtual environments



Blair MacIntyre, Steven Feiner

November 1996 **Proceedings of the 9th annual ACM symposium on User interface software and technology**

Publisher: ACM Press

Full text available: [pdf\(1.68 MB\)](#)

Additional Information: [full citation](#), [references](#), [citings](#), [index terms](#)

Keywords: distributed shared memory, distributed virtual environments, shared-data object model, virtual reality

17 Client-server computing



Alok Sinha

July 1992 **Communications of the ACM**, Volume 35 Issue 7

Publisher: ACM Press

Full text available: [pdf\(7.53 MB\)](#)

Additional Information: [full citation](#), [references](#), [citations](#), [index terms](#), [review](#)

Keywords: client-server computing

18 Building reliable mobile-aware applications using the Rover toolkit

Anthony D. Joseph, M. Frans Kaashoek

October 1997 **Wireless Networks**, Volume 3 Issue 5

Publisher: Kluwer Academic Publishers

Full text available: [pdf\(371.04 KB\)](#)

Additional Information: [full citation](#), [abstract](#), [references](#), [citations](#), [index terms](#)

This paper discusses extensions to the Rover toolkit for constructing reliable mobile-aware applications. The extensions improve upon the existing failure model, which addresses client or communication failures and guarantees reliable message delivery from clients to server, but does not address server failures (e.g., the loss of an incoming message due to server failure) (Joseph et al., 1997). Due to the unpredictable, intermittent communication connectivity typically found in mobile client ...

19 Optimistic replication



Yasushi Saito, Marc Shapiro

March 2005 **ACM Computing Surveys (CSUR)**, Volume 37 Issue 1

Publisher: ACM Press

Full text available: [pdf\(656.72 KB\)](#)

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Data replication is a key technology in distributed systems that enables higher availability and performance. This article surveys optimistic replication algorithms. They allow replica contents to diverge in the short term to support concurrent work practices and tolerate failures in low-quality communication links. The importance of such techniques is increasing as collaboration through wide-area and mobile networks becomes popular. Optimistic replication deploys algorithms not seen in tradition ...

Keywords: Replication, disconnected operation, distributed systems, large scale systems, optimistic techniques

20 A framework for the assessment of operating systems for small computers



Hossein Saiedian, Munib Siddiqi

April 1996 **ACM SIGICE Bulletin**, Volume 21 Issue 4

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A number of high performance operating systems are now available for small computers on different hardware platforms. These operating systems offer many advanced features formerly reserved for their workstation and minicomputer counterparts. This article surveys the most widely used of such operating systems, namely OS/2, Windows NT, Linux and Macintosh System 7.5. It provides an account on the history, design objectives and evolution of these operating systems and discusses their key features, ...

Keywords: CP/M, DOS, Linux, Macintosh, Microcomputers, OS/2, Operating Systems,

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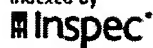
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| <u>#14</u> | ((disaster<in>metadata) <and> (recovery<in>metadata))
<and> (remote<in>metadata) |
| <u>#15</u> | ((disaster<in>metadata) <and> (recovery<in>metadata))
<and> (remote<in>metadata) |

#16 ((synchronous<in>metadata) <and> (copy<in>metadata))
<and> (remote<in>metadata)

#17 ((synchronous<in>metadata) <and> (copy<in>metadata))
<and> (remote<in>metadata)

#18 ((synchronous<in>metadata) <and> (copy<in>metadata))
<and> (attributes<in>metadata)

#19 ((synchronous<in>metadata) <and> (copy<in>metadata))
<and> (attribute<in>metadata)

#20 ((synchronous<in>metadata) <and> (copy<in>metadata))
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#21 ((synchronous<in>metadata) <and> (copy<in>metadata))
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#22 ((peer<in>metadata) <and> (copy<in>metadata))<and>
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



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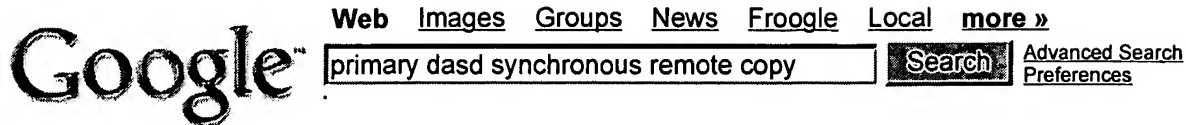
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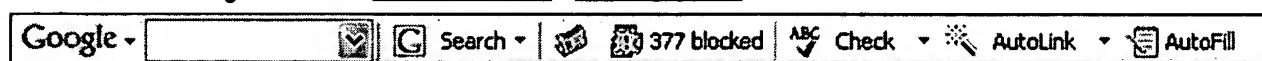
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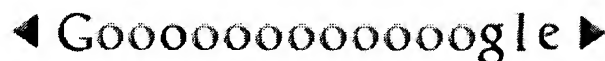
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OnCourse allows secure **peer-to-peer** file transfers between the Celerra family of NAS ... for \$975.00 for the first **copy** and \$150.00 for additional **copies**. ...
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By incorporating SATA drives, a fully-integrated InfoStation 16-bay **RAID** system can ... **HP** provided the SAN equipment, which consisted of an **HP EVA storage** ...

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The 30% **RAID-5** is for any Sequential **write** you may need to optimise. ... Yes I agree, but **synchronous** Remote **Copy** cannot guarantee zero data loss. ...

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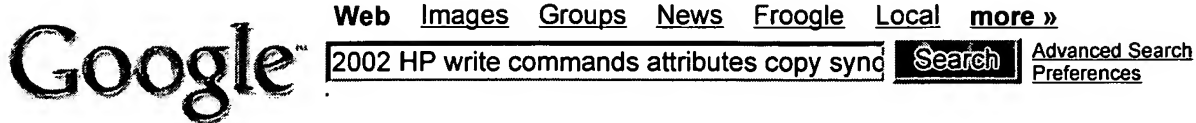
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- 1 Read write device for optical memory and method therefore**
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 (+3)
 EC: IPC: **G11B7/00; G11B7/00**
 Publication info: **US2006018233** - 2006-01-26
- 2 Method for quickly producing read and/or write readiness of an apparatus for reading from and/or writing to an optical recording medium, and correspondingly configured apparatus**
 Inventor: UHDE DIETMAR (DE); BUECHLER CHRISTIAN Applicant: THOMSON LICENSING SA (FR)
 (DE)
 EC: G11B7/09M; G11B19/12 IPC: **G11B7/09; G11B19/12; G11B7/09** (+2)
 Publication info: **TW226053B** - 2005-01-01
- 3 Tamper resistant write once recording of a data storage cartridge having rewritable media**
 Inventor: JAQUETTE GLEN A (US) Applicant:
 EC: G11B15/04; G11B15/05; (+1) IPC: **G11B19/02; G11B19/02; G11B23/02** (+3)
 Publication info: **US2006012910** - 2006-01-19
- 4 Read/write circuit for accessing chalcogenide non-volatile memory cells**
 Inventor: LI BIN (US); KNOWLES KENNETH R (US); Applicant:
 (+1)
 EC: IPC: **G11C11/00; G11C11/00; G11C11/00** (+1)
 Publication info: **US2006013037** - 2006-01-19
- 5 IO-stream adaptive write caching policy adjustment**
 Inventor: SCHNAPP MICHAEL G (TW); CHAN CHIH-CHUNG (TW) Applicant: INFORTREND TECHNOLOGY INC
 EC: IPC: **G06F12/00; G06F12/00**
 Publication info: **US2006015688** - 2006-01-19
- 6 Adaptive write caching for virtual storage system**
 Inventor: SCHNAPP MICHAEL GORDON (TW); CHAN CHIH-CHUNG (TW) Applicant: INFORTREND TECHNOLOGY INC (TW)
 EC: IPC: **G06F12/08; G06F11/20; G06F11/20** (+1)
 Publication info: **GB2416413** - 2006-01-25
- 7 DATA STORAGE MEDIUM READ/WRITE UNIT COMPRISING A HEAT SINK**
 Inventor: CHAPEL CLAUDE (FR) Applicant: THOMSON LICENSING (FR)
 EC: G11B33/08; G11B33/12; (+1) IPC: **G11B33/08; G11B33/12; G11B33/14** (+5)
 Publication info: **EP1618569** - 2006-01-25
- 8 Nonvolatile memory vertical ring bit and write-read structure**
 Inventor: SUNDSTROM LANCE (US) Applicant: HONEYWELL INT INC (US)
 EC: IPC: **G11C11/00; G11C11/00**
 Publication info: **US2006007728** - 2006-01-12
- 9 Method for optimizing dynamic stroke in the self servo-write process**
 Inventor: CALFEE GARY W (US); EHRLICH RICHARD M Applicant: MATSUSHITA ELECTRIC IND CO LTD (JP)
 (US)
 EC: IPC: **B41G3/00; B41G3/00**
 Publication info: **US2006005403** - 2006-01-12

**10 METHOD AND SYSTEM FOR PROVIDING COMMON READ AND WRITE
WORD LINES FOR A SEGMENTED WORD LINE MRAM ARRAY**

Inventor: YANG HSU KAI KARL (US); SHI XIZENG (US); **Applicant:** HEADWAY TECHNOLOGIES INC (US); YANG
(+2) HSU KAI KARL (US); (+3)

EC: **IPC:** (IPC1-7): B01F15/02

Publication info: **WO2005123235** - 2005-12-29

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- 1 Method, system, and program for storing sensor data in autonomic systems**
Inventor: KANDIL MOKHTAR (CA); MARKL VOLKER G (US) Applicant: IBM (US)
EC: IPC: **G06F12/00; G06F12/00**
Publication info: **US2006020760** - 2006-01-26
- 2 Hierarchical drift detection of data sets**
Inventor: GARG NEERAJ (US); DALY MICHAEL T (US); (+3) Applicant: MICROSOFT CORP (US)
EC: IPC: **G06F17/30; G06F17/30**
Publication info: **US2006020594** - 2006-01-26
- 3 Data protecting apparatus and data protecting method**
Inventor: MORINO SHIGERU (JP) Applicant: TOSHIBA TEC KK
EC: IPC: **G06F12/14; G06F12/14**
Publication info: **US2006020823** - 2006-01-26
- 4 Universal container for audio data**
Inventor: STEWART WILLIAM G (US); MCCARTNEY JAMES E (US); (+1) Applicant:
EC: IPC: **G10L19/00; G10L19/00**
Publication info: **US2006020474** - 2006-01-26
- 5 Digital video storage system and related method of storing digital video data**
Inventor: TSAI CHING-YU (TW); HUANG CHI-HUI (TW) Applicant:
EC: IPC: **H04N5/781; H04N5/781**
Publication info: **US2006018633** - 2006-01-26
- 6 Method and device to detect the likely onset of thermal relaxation in magnetic data storage devices**
Inventor: PHILLIPS GAVIN N (NL); BOEVE HANS M B (NL) Applicant: KONINKL PHILIPS ELECTRONICS NV (NL)
EC: **G11C29/50** IPC: **G11C29/50; G11C11/14; G11C11/00 (+3)**
Publication info: **US2006018148** - 2006-01-26
- 7 Data migration in storage system**
Inventor: MATSUNAMI NAOTO (JP); SHIROGANE TETSUYA (JP); (+2) Applicant: HITACHI LTD (JP)
EC: IPC: **G06F15/16; G06F12/16; G06F12/16 (+1)**
Publication info: **US2006020663** - 2006-01-26
- 8 Data storage module suspension system**
Inventor: IVES THOMAS W (US); FASEN DONALD J (US) Applicant:
EC: **B81B3/00P; G11B5/55D2; (+2)** IPC: **G11B9/00; G11B21/16; G11B5/48 (+3)**
Publication info: **US2006018053** - 2006-01-26
- 9 Method and system for storing and retrieving data using hash-accessed multiple data stores**
Inventor: SNAPP ROBERT F (US); PAYNE DAVID J (US); (+1) Applicant: US POSTAL SERVICE
EC: IPC: **G06F17/30; G06F17/30**
Publication info: **US2006020575** - 2006-01-26

10 Data processing apparatus and method, data processing program, and storage medium

Inventor: HAYASHI JUNICHI (JP)

Applicant: CANON KK (JP)

EC: G06T1/00W

IPC: *G06T1/00; H04L9/00; G06T1/00* (+1)

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- 1 Network storage system and handover method between plurality of network storage devices**
 Inventor: MUROTANI AKIRA (JP) Applicant:
 EC: IPC: **G06F12/00; G06F12/00**
 Publication info: **US2006020636** - 2006-01-26
- 2 Method and device to detect the likely onset of thermal relaxation in magnetic data storage devices**
 Inventor: PHILLIPS GAVIN N (NL); BOEVE HANS M B Applicant: KONINKL PHILIPS ELECTRONICS NV (NL)
 (NL)
 EC: **G11C29/50** IPC: **G11C29/50; G11C11/14; G11C11/00** (+3)
 Publication info: **US2006018148** - 2006-01-26
- 3 Thin-film battery devices and apparatus for making the same**
 Inventor: JENSON MARK L (US) Applicant: CYMBET CORP
 EC: IPC: **H01M4/04; H01M6/00; H01M6/46** (+6)
 Publication info: **US2006019157** - 2006-01-26
- 4 Applying storage device commit-cached-data-to-media functionality to improve data security in systems that allow storage devices to cache writes**
 Inventor: SCHNAPP MICHAEL G (TW); HUNG CHING-HAI (TW) Applicant: INFORTREND TECHNOLOGY INC
 EC: IPC: **G06F12/00; G06F12/00**
 Publication info: **US2006020752** - 2006-01-26
- 5 Network storage system and handover method between a plurality of network storage devices**
 Inventor: MUROTANI AKIRA (JP) Applicant: HITACHI LTD (JP)
 EC: IPC: **G06F17/30; G06F17/30**
 Publication info: **EP1622048** - 2006-02-01
- 6 INTELLIGENT DATA STORAGE AND PROCESSING USING FPGA DEVICES**
 Inventor: FRANKLIN MARK ALLEN (US); CYTRON RON K Applicant: UNIV WASHINGTON (US)
 (US); (+3)
 EC: IPC: (IPC1-7): **G06F17/30; G06F15/78**
 Publication info: **CA2523548** - 2005-05-26
- 7 INTELLIGENT DATA STORAGE AND PROCESSING USING FPGA DEVICES**
 Inventor: CYTRON RONALD K (US); FRANKLIN MARK A Applicant: UNIV WASHINGTON (US); DATA SEARCH
 (US); (+3) SYSTEMS INC (US)
 EC: IPC: (IPC1-7): **G06F1/00**
 Publication info: **CA2522862** - 2005-03-24
- 8 System and method for content management over network storage devices**
 Inventor: COILE BRANTLEY W (US) Applicant: CORAID INC (US)
 EC: **H04L29/06; H04L29/06C8A** IPC: **H04L29/06; G06F17/30; H04L29/06** (+1)
 Publication info: **US6990481** - 2006-01-24
- 9 Fastening device for data storage devices**
 Inventor: PENG WEN-TANG (TW); CHENG CHENG-LUNG Applicant: HON HAI PREC IND CO LTD (TW)
 (TW); (+1)

EC:

IPC: (IPC1-7): H05K7/14; G06F1/16; G11B33/02

Publication info: **TW254871Y** - 2005-01-01

10 ELECTRIC BATTERIES AND STORAGE DEVICES

Inventor: SALAUZE JEAN

Applicant: ACCUMULATEURS FIXES

EC:

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synchronous in the title AND **copy** in the title or abstract

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- 1 Method and apparatus for aligning data in a wide, high-speed, source synchronous parallel link**
 Inventor: BHATTACHARYA DIPANKAR (US); PRIYADARSHAN BANGALORE (US); (+2)
 EC: Applicant: CISCO TECHNOLOGY INC A CALIFOR (US)
 IPC: **G06F12/00; G06F12/00; (IPC1-7): G06F12/00**
 Publication info: **US2005066142** - 2005-03-24
- 2 Apparatus, system, and method for synchronizing an asynchronous mirror volume using a synchronous mirror volume**
 Inventor: MICKA WILLIAM F (US); SPEAR GAIL A (US); Applicant: (+1)
 EC: IPC: (IPC1-7): G06F12/16
 Publication info: **US2005251633** - 2005-11-10
- 3 System and method for facilitating data flow between synchronous and asynchronous processes**
 Inventor: MOORE DAVID WAYNE (US); PERRY FREDERICK STEPHEN (US); (+1)
 EC: Applicant: IBM (US)
 IPC: **G06F12/00; G06F12/00; (IPC1-7): G06F12/00**
 Publication info: **US2005050113** - 2005-03-03
- 4 Synchronous stream cipher**
 Inventor: JANSEN CORNELIS J A (NL); ROELSE PETRUS L A (NL)
 EC: H04L9/18 Applicant: IPC: **H04L9/18; H04L9/18; (IPC1-7): H04L9/00**
 Publication info: **US2003194087** - 2003-10-16
- 5 Anti-synchronous radio channel slicing for smoother handover and continuous service reception**
 Inventor: WALSH ROD (FI); HAKULINEN HARRI (FI)
 EC: H04Q7/38H Applicant: NOKIA CORP (FI)
 IPC: **H04Q7/38; H04Q7/38; (IPC1-7): H04Q7/00**
 Publication info: **US2004057400** - 2004-03-25
- 6 CONFERENCING WITH SYNCHRONOUS PRESENTION OF MEDIA PROGRAMS**
 Inventor: BILLMAIER JAMES
 EC: H04N7/15 Applicant: DIGEO INC (US)
 IPC: **H04N7/15; H04N7/15; (IPC1-7): H04N7/14 (+1)**
 Publication info: **WO03058965** - 2003-07-17
- 7 Track-synchronous audio signal recording method and apparatus**
 Inventor: ROH SEUNG PHIL (KR); PARK JAE WAN (KR); Applicant: (+1)
 EC: IPC: **G11B7/00; G11B20/10; G11B27/10 (+4)**
 Publication info: **US2003039190** - 2003-02-27
- 8 Power conservation with a synchronous master-slave serial data bus**
 Inventor: WANG WEI (US); MARTEN VICTOR (US); Applicant: SEMTECH CORP (US)
 EC: H04L7/00B (+1) IPC: **H04L7/00; H04L7/00; (IPC1-7): G06F13/00**
 Publication info: **US6557063** - 2003-04-29
- 9 Synchronous PCR amplification and hybridization process**
 Inventor: HUANG DAOPEI (CN)
 EC: Applicant: HUANG DAOPEI (CN)
 IPC: **C12Q1/68; C12Q1/68; (IPC1-7): C12Q1/68**
 Publication info: **CN1398984** - 2003-02-26

10 Self-synchronous transfer control circuit and data driven information processing device using the same

Inventor: UNEYAMA TAKUJI (JP); TAKASE MOTOKI (JP); **Applicant:**

(+1)

EC:

IPC: G06F15/82; H04L5/04; G06F15/76 (+2)

Publication Info: US2001028629 - 2001-10-11

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RESULT LIST

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raid in the title AND **storage** in the title or abstract
(Results are sorted by date of upload in database)

- 1 Management method for spare disk drives a RAID system**
Inventor: VAN GUNDY STEVEN R (US); BENHASE MICHAEL T (US); (+2) Applicant: IBM (US)
EC: IPC: **G06F11/00; G06F11/00**
Publication Info: **US2006015771** - 2006-01-19
- 2 Raid controller using capacitor energy source to flush volatile cache data to non-volatile memory during main power outage**
Inventor: ASHMORE PAUL A (US); LINTZ DWIGHT O (US); (+3) Applicant: DOT HILL SYSTEMS CORP (US)
EC: IPC: **G06F12/16; G06F12/16**
Publication info: **US2006015683** - 2006-01-19
- 3 Method for snooping raid 1 read transactions by a storage device**
Inventor: YOUNG B ARLEN (US) Applicant: ADAPTEC INC (US)
EC: IPC: **G06F12/00; G06F12/00**
Publication info: **US6988166** - 2006-01-17
- 4 SAN based application recognition (SBAR) for RAID controller**
Inventor: BALASUBRAMANIAN SRIDHAR (US) Applicant:
EC: IPC: (IPC1-7): **G06F12/00**
Publication info: **US2005289296** - 2005-12-29
- 5 Method and apparatus for decreasing failed disk reconstruction time in a raid data storage system**
Inventor: WOOD ROBERT B (US); KUNZMAN CHARLES D (US) Applicant: SUN MICROSYSTEMS INC (US)
EC: IPC: (IPC1-7): **G06F11/00**
Publication info: **US2005283654** - 2005-12-22
- 6 Method, apparatus and program storage device for keeping track of writes in progress on multiple controllers during resynchronization of RAID stripes on failover**
Inventor: TESKE JOHN T (US); WILLIAMS JEFFREY L (US) Applicant: XIOTECH CORP
EC: IPC: (IPC1-7): **G06F12/00**
Publication info: **US2005278476** - 2005-12-15
- 7 RAID controller module**
Inventor: CHANG YUAN-LUNG (TW); CHANG YUAN-HUEI (TW) Applicant: ETRUNK TECHNOLOGIES INC (TW)
EC: IPC: (IPC1-7): **G06F12/00**
Publication info: **US2005268035** - 2005-12-01
- 8 Low cost raid with seamless disk failure recovery**
Inventor: MCNEILL ANDREW B JR (US); NEWSOM THOMAS H (US) Applicant:
EC: IPC: (IPC1-7): **G06F11/00**
Publication info: **US2005262385** - 2005-11-24
- 9 Apparatus for checking data coherence, raid controller and storage system having the same, and method therefor**
Inventor: PAN JUI-YAO (TW); CHEN JUNG-YAO (TW) Applicant: INFORTREND TECHNOLOGY INC
EC: IPC: **G06F7/38; G06F7/38; (IPC1-7): G06F7/38**
Publication info: **US2005228842** - 2005-10-13

10 System and method for reorganizing data in a raid storage system

Inventor: THOMPSON MARK J (US); SCHULTZ STEPHEN Applicant:

M (US)

EC:

IPC: G06F11/00; G06F12/00; G06F12/16 (+4)

Publication info: US2005166085 - 2005-07-28

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<input type="checkbox"/>	L58	L57 and ((write) same (multiple near5 storage))	8
<input type="checkbox"/>	L57	L56 and (write near5 command\$1)	35
<input type="checkbox"/>	L56	L55 and (first near5 storage) and (second near5 storage)	55
<input type="checkbox"/>	L55	L54 and (data near5 storage) and device\$1	66
<input type="checkbox"/>	L54	L53 and (asynchronous near5 copy)	84
<input type="checkbox"/>	L53	(synchronous near5 copy) and @py<=2004	480
<input type="checkbox"/>	L52	L51 and (asynchronous near10 (copy near5 attribute))	0
<input type="checkbox"/>	L51	L50 and ((synchronous near5 copy) same (second near5 storage))	1
<input type="checkbox"/>	L50	L48 and (asynchronous near5 copy)	1
<input type="checkbox"/>	L49	L48 and asynchronous	1
<input type="checkbox"/>	L48	L47 and (second near5 data)	1
<input type="checkbox"/>	L47	L46 and (synchronous near5 copy)	1
<input type="checkbox"/>	L46	L44 and write and storage	1
<input type="checkbox"/>	L45	L44 and srite and storage	0
<input type="checkbox"/>	L44	l43 and synchron\$3	1
<input type="checkbox"/>	L43	6950915.pn.	2
<input type="checkbox"/>	L42	L41 and (copy near5 attribute\$1)	6
<input type="checkbox"/>	L41	L40 and (copy same (first near5 storage))	161
<input type="checkbox"/>	L40	L39 and (read same write) and command\$1	1106
<input type="checkbox"/>	L39	L38 and synchron\$3	2445
<input type="checkbox"/>	L38	L37 and (remote near5 storage)	14202
<input type="checkbox"/>	L37	storage near5 devices	142603
<input type="checkbox"/>	L36	L35 and (storage near5 devices)	34
<input type="checkbox"/>	L35	pprc near5 operation\$1	53
<input type="checkbox"/>	L34	'peer to peer remote copy'	0
<input type="checkbox"/>	L33	'peer to peer'	0
<input type="checkbox"/>	L32	(storage near5 devices) and 'peer to peer'	0
<input type="checkbox"/>	L31	remote and copy and 'peer to peer'	0
<input type="checkbox"/>	L30	L29 and 'peer to peer'	0

<input type="checkbox"/>	L29	L28 and (remote near5 copy)	13
<input type="checkbox"/>	L28	L26 and (write near5 data)	13
<input type="checkbox"/>	L27	L26 and (write near5 data)	0
<input type="checkbox"/>	L26	L25 and (cache near5 copy)	13
<input type="checkbox"/>	L25	L24 and cache	29
<input type="checkbox"/>	L24	L23 and (storage near5 devices)	30
<input type="checkbox"/>	L23	L22 and (synchronous near5 copy)	32
<input type="checkbox"/>	L22	L21 and command\$1 and write and read and attribut\$1	490
<input type="checkbox"/>	L21	L20 and (second near5 storage) and synchron\$3	11129
<input type="checkbox"/>	L20	(first near5 storage) and synchron\$3	17577
<input type="checkbox"/>	L19	L18 and (remote near5 devices)	5
<input type="checkbox"/>	L18	L17 and (storage near5 devices)	31
<input type="checkbox"/>	L17	L16 and synchron\$3	31
<input type="checkbox"/>	L16	l13 and read and write and commands	186
<input type="checkbox"/>	L15	L13 and (synchronous near5 copy)	1
<input type="checkbox"/>	L14	L13 and (full near5 duplex)	5
<input type="checkbox"/>	L13	(storage near5 devices) and (symmetric near5 multiprocessor\$1)	1194
<input type="checkbox"/>	L12	(storage near5 devices) and (symmetric near5 multiprocessor\$1)	0
<input type="checkbox"/>	L11	L8 and RISC	0
<input type="checkbox"/>	L10	L8 and risc	0
<input type="checkbox"/>	L9	L8 and (risc near5 processors)	0
<input type="checkbox"/>	L8	raid near5 tank	76
<input type="checkbox"/>	L7	(first near5 risc) and (second near5 risc) and (first near5 cache) and (second near5 cache)	7
<input type="checkbox"/>	L6	(primary near5 risc) and (secondary near5 risc) and (primary near5 cache) and (secondary near5 cache)	0
<input type="checkbox"/>	L5	(primary near5 risc) and (secondary near5 risc) and (primary near5 cache) and (secondary near5 cache) and cluster and (file\$1 or record\$1)	0
<input type="checkbox"/>	L4	(primary near5 risc) and (secondary near5 risc) and (primary near5 cache) and (secondary near5 cache) and cluster and (file\$1 or record\$1) and @py<=2003	0
<input type="checkbox"/>	L3	(primary near5 risc) and (secondary near5 risc) and (primary near5 cache) and (secondary near5 cache) and cluster and (file\$1 or record\$1) and log and updat\$3 and @py<=2003	0
<input type="checkbox"/>	L2	(primary near5 risc) and (secondary near5 risc) and (primary near5 cache) and (secondary near5 cache) and cluster and write and data and storage and devices and synchron\$3 and remote and copy and write and read and (file\$1 or record\$1) and log and updat\$3 and @py<=2005	0
<input type="checkbox"/>	L1	(primary near5 risc) and (secondary near5 risc) and (primary near5 cache) and (secondary near5 cache) and cluster and write and data and storage and devices and synchron\$3 and remote and copy and write and read and (file\$1 or record\$1) and log and updat\$3 and @py<=2004	0

END OF SEARCH HISTORY